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CIRCULAR LETTER NO. 8

SUBJECT: Notes on Care of battle Casualties.

The contents of several previous circular letters pertaining to the surgical management of the wounded are consolidated and in certain instances extended or modified in the following recommendations.

1. The care of the wounded must always be shaped by conditions and circumstances that govern the tactical situation at the moment. It has been shown by this Theater that the surgery of war need not be molded by concessions to the need for haste and the confusion of caring for overwhelming numbers of patients. Military surgery is not a crude departure from accepted surgical standards, but a development of the science of surgery to carry out a specialized and highly significant mission. Modern surgical treatment employs many adjuvants to operative techniques, such as chemotherapy, fluid replacement therapy, the transfusion of whole blood and fractions of blood employed as substitutes, potent anesthetic agents and narcotics. These tools are as important to the military surgeon as his scalpel, but are equally dangerous to the patient if used without expert precision. One of the major responsibilities of the military surgeon is to make full use of these and similar measures and at the same time to avoid the dangers that may attend their usage.

The ever-present necessity for evacuation of the wounded to the rear is in fundamental conflict with ideal surgical management of the individual patient. To minimize this conflict, close coordination between the functions of administration and professional services is required. It is the responsibility of the medical officer charged with the surgical management of the patient to place technical procedures properly, both in time and in space, with due regard to the tactical situation on the one hand and to the welfare of the patient on the other. Unless the surgeon visualizes his position and the function of his hospital in relation to other surgeons and other hospitals, he may become confused in the mission he is to perform. Although some needed operation may be performed correctly, the military effort may be impeded and unforeseen harm done to the patient if the operation is done at the wrong time or in the wrong place.

It is the responsibility of administrative officers charged with the establishment of evacuation and hospitalization policies to adapt the schedules of movement of patients to the maintenance of highest standards of surgical treatment. Priority of movement must be accorded to patients with certain types of injuries just as the duration of hospitalization in a given zone must be differentially adjusted to the urgent surgical needs of the patients. The term "non-

"transportable" as relating to the unfitness of battle casualties for inter-hospital transfer must, when military necessity permits, be extended beyond actual danger to life by a consideration of the likelihood of deformity, ultimate disability, and delay of recovery when these hazards exist.

Just as the placement of various types of hospitals and consequently the provision of the facilities for surgery are determined by the geographic deployment of a military force, phases of surgical management exist that in general will conform with military echelons. These phases of surgical management are: first aid measures, initial wound surgery, reparative wound surgery, reconstructive surgery, and rehabilitation measures.

First Aid Measures. Within the divisional area surgical management is limited to first aid measures and emergency resuscitation. Hemorrhage is controlled, splints and dressings applied, morphine administered for pain, plasma infused for resuscitation, a booster dose of tetanus toxoid is given, and chemotherapy initiated.

Initial surgery. Actual conditions of warfare will determine both the facilities provided for emergency wound surgery and their location with reference to the combat area. In general, initial surgery is concerned with complete resuscitation so that surgery may be performed, and with surgical procedures designed to prevent or eradicate wound infection. Many of the seriously wounded casualties can be resuscitated only by a surgical operation in conjunction with transfusion and plasma therapy. For this reason, it is important that delays for the purpose of resuscitation ahead of an installation equipped for major surgery be kept at a minimum. Placement of the advance surgical hospital in physical proximity to the divisional clearing station accomplishes this end.

Reparative surgery. The general hospitals of the communications zone receive casualties from the hospitals of the forward area for further surgical management. As the initial wound operation is by definition a limited procedure, nearly every case requires further treatment. Soft part wounds, purposely left unsutured at the initial operation, are closed by suture, usually at the time of the first dressing on or after the fourth day. Fractures are accurately reduced and immobilized until bony union takes place.

designed to prevent or cut short wound infection either before it is established or at the time of its inception, this phase in the surgical care of the wounded is concerned with shortening the period of wound healing and seeks as its objectives the early restoration of function and the return of a soldier to duty with a minimum number of days lost. In addition, it affords the return of patients to the United States at an earlier date and in better condition and minimizes the ultimate disability and deformity in the seriously wounded.

The success of this important phase of surgery depends on the provision of an adequate period of hospitalization in addition to competent surgical care, particularly in specialized fields. It is not to be confused with the reconstructive phase of surgery, which may be postponed until return to the zone of the interior. The ideal time for the procedures of reparative surgery will be found between the fourth and tenth days after wounding. The patient then becomes "non-transportable" for a period of time which, in the case of fractures, may extend to eight or ten weeks. Transfer of patients between fixed hospitals within the zone of communications must be regulated with these considerations in mind, otherwise the objectives of this phase of surgical management may be sacrificed.

The establishment of special centers within general hospitals for certain types of surgery during this phase is highly desirable, as the procedures are oftentimes of considerable magnitude and call for mature and experienced professional judgment. Advancement of general hospitals in close support of Army or utilization of air evacuation from Army to more remote fixed installations are two measures that further the establishment of a program of reparative surgery.

Reconstructive Surgery. Early evacuation to the United States is desirable for patients whose return to duty cannot be anticipated within the limits of the hospitalization policy of an overseas theater. The phases of reconstructive surgery and rehabilitation may then be integrated.

2. Wound Management.

a. Initial wound surgery.

(1) X-ray. In the preoperative examination of a battle casualty X-ray examination is essential.

(2) Adequate assistance and instruments, a good light, and access to the wound that is unhampered by faulty position of the patient are basic requirements. Ample preparation of a wide field by shaving the skin will allow for extension of the incision or counterincision.

(3) Bold incision is the first essential step in an operation on a wound. Adequate exposure is necessary to carry out excision of devitalized tissues. On the extremity the line of the incision is placed parallel with the long axis of the limb; elsewhere it follows the natural lines of skin structure. Only the devitalized skin of the margins of the wound is excised in a strip rarely wider than 2 to 3 mm. The creation of circular skin defects is avoided.

(4) Incision and excision of the fascial layers is performed in the same manner to give free access to devitalized muscle. Unrestricted exposure of successive anatomic layers permits the complete excision of devitalized muscle and the removal of foreign bodies.

(5) The surgeon must be familiar with the blood supply of muscles, particularly large groups like the gastrocnemius-soleus muscles of the calf and respect these vessels in his dissection. Deep recesses of the wound containing foreign bodies may be approached by counterincisions planned anatomically rather than by sacrificing normal muscle structures.

(6) Use fine hemostats. Use the finest ligature compatible with the procedure. Include the smallest possible amount of tissue in ligating a bleeding point. Do not repeatedly bite the wound with tissue forceps. Sponge gently with pressure instead of wiping. Remaining devitalized tissue produced by the missile or by the surgeon must slough before the wound can be closed by secondary suture.

(7) Large wounds in regions of heavy muscles, particularly when complicated by comminuted fracture, require especial care. The depths of these wounds must be opened by a long incision with counterincision if necessary to allow free dependent drainage.

(8) Only enough dry, fine, mesh gauze is used to separate the surfaces of the wound. It should be smoothly laid in the wound - not "packed".

(9) Ether, white soap, and benzene, have slight but definite necrotizing effects on living muscles. Green soap and various other substances used as detergents have greater necrotizing effects. Physiological saline solution is relatively innocuous. In general, progress in wound management points away from the introduction of any agent into a wound, either for its supposed mechanical or antiseptic effect.

(10) Old wounds (48 hours or longer) are managed in accord with the same principles, except that in selected cases of established pyogenic infection and anaerobic cellulitis with toxicity the general condition of the patient to withstand radical surgery may be improved by immobilization, penicillin and repeated blood transfusions until an optimum time is selected for intervention. In postponement of surgery the advantage that accrues from the immediate drainage of septic hematomas, large masses of dead muscle, and fascial plane abscesses, is not to be forgotten. Postponement of surgery is not justified if clostridial myositis (gas gangrene) may be present.

(11) Proper transportation splinting is provided for skeletal and joint injuries. Soft part wounds are supported by firm pressure dressings and may, if extensive, be advantageously enclosed in a light plaster. Care is taken to avoid any constricting action of a pressure dressing placed on an extremity. Plaster casts must always be padded and split or bivalved before the patient is returned to the ward.

b. Preparative wound surgery.

(1) On arrival at a hospital where bed care can be assured for a period of at least fifteen days (soft part wounds) the original dressing is removed in the operating room under aseptic precautions. X-ray films should be at hand. If the primary wound operation has been complete and has been properly done, all superficial wounds and many deep wounds may be closed by secondary suture at this time (4 to 10 days). Foreign bodies in soft parts adjacent to the wound are removed. Following suture, the part is immobilized, preferably by a light plaster, or if this is impractical, by bed rest.

(2) The presence of residual dead tissue or established infection manifested by profuse discharge of pus, reddening and edema of the wound margins, persistent fever or toxicity is an indication for delay in secondary suture. When these manifestations are present but minimal, the wound is allowed to "clean up". This process can be hastened by moist dressings or by additional surgical excision of devitalized fragments. Secondary suture can then be performed in a few days. If established infection is severe, or if the patient is toxic and anemic from deep seated sepsis, a course of penicillin therapy and blood transfusions is instituted and followed by radical wound revision, and staged closure.

(3) Wounds that have been laid open properly at the initial operation tend to gape widely and give the impression of extensive skin loss. This appearance is actually due to loss of support of the deep fascia. Skin defects are more apparent than real in the majority of cases and closure of a defect is made from local tissue with suture in a straight line when possible. Undermining with advancement or rotation of flaps provides sufficient skin in nearly all

instances and is preferable to grafting.

(4) technical considerations that are important to the success of secondary wound closures are:

- (a) Atraumatic handling of tissue.
- (b) Avoidance of tension sutures.
- (c) Accurate approximation of skin margins. The epithelial bridge is the main support of the wound for a considerable period of time.
- (d) Obliteration of dead spaces by pressure dressings and immobilization. Stab wound drainage may be instituted when desired and is preferable to drainage through the suture line.
- (e) Leaving sutures in place for twelve days if stitch infection does not develop.
- (f) suture in straight lines rather than the creation of sharp angles.

(5) Preliminary bacteriologic analysis of the flora of a wound does not provide information pertinent to making the decision to perform secondary suture or allow the prediction of the result. If the suture is not successful because of infection, appropriate studies and corrective therapy is instituted before resuture is attempted.

(6) The conditions that most often jeopardize results are:

- (a) suture of a wound that is discharging pus. This usually means dead tissue in the depths.
- (b) too early motion. (Wounds breaking down for this reason should be immediately resutured.)
- (c) Unrecognized foreign bodies adjacent to the wound.

c. Closed Plaster Treatment.

(1) the regimen of closed plaster management of war wounds is not considered as satisfactory as the method described above when field conditions permit the use of the latter.

(2) while the necessity for the rapid turnover of large numbers of casualties might justify an adoption of the closed plaster method of management of compound fractures, a high penalty in the form of skeletal deformity would be the inevitable result. Results obtained by secondary suture do not justify the use of closed plaster for soft part wounds.

(3) when it is desired to allow granulations to cover exposed bone in deep irregular wounds, the wound may be encased in plaster subject to infrequent changes. This is also an accepted method of management for established infection of bone, particularly when the wound has caused an extensive loss of

overlying soft parts or there is a large bone defect. before application of the plaster, all devitalized tissue and loose bone fragments are excised. There should be no pocketing or pooling of pus in the fracture site or adjacent fascial compartments. Small surfaces of bare cortical bone may be removed surgically when this permits closure of the defect by suture or skin graft.

3. Regional Surgery.

a. Cranio-cerebral Wounds.

(1) After complete debridement with inspection of the underlying bone for fracture, wounds of the scalp are closed by primary suture.

(2) Deep infection of penetrating wounds of the skull is almost always associated with incomplete removal of devitalized brain substance. The extent of the necessary debridement oftentimes is indicated by indriven bone fragments which are demonstrable by x-ray examination. stereoscopic roentgenograms are helpful. A reduction in the incidence of infection can be effected by extending the debridement so that these fragments of bone and the tissue that surrounds them are removed at the time of the initial surgical procedure.

(3) Dura defects are repaired by living grafts of fascia or pericranium. The scalp is closed by suture.

(4) When a patient arrives at the base following initial debridement and closure of the wound in the forward area, neurological changes are carefully noted. When compared with former observations these may suggest improvement or regression. Signs or symptoms of increasing intracranial pressure usually indicate deep wound infection, hematoma or a mass of residual necrotic tissue. The tension and healing in the scalp flap and wound are at once determined. Should stereoscopic x-ray studies disclose the presence of residual bone fragments, secondary wound debridement can then be more readily directed. Even in the absence of symptoms it is usually wiser to remove large or clustered bone fragments. On the other hand, if the fragments are small or in a dangerous location operation may be withheld provided the patient is doing well and can be held for a period of observation. If secondary operation is to be carried out, necrotic or infected tissue and hematoma are removed and wound closure effected, even though frankly purulent cerebritis has been encountered. At times a temporary drain to a large dead space is permissible or repeated aspirations employed, but only rarely is it necessary to exteriorize the infected area.

b. Eye Injuries.

(1) Conservation in the enucleation of eyes in forward installations is advisable. Inasmuch as sympathetic ophthalmia never develops before ten days and usually not before two weeks after the initial injury, the first two weeks following the injury may be considered the "safe period". Therefore, in forward installations enucleations should be done only when there is extensive damage to the eye and orbit and removal of the ocular remnants is a necessary procedure in the debridement of the area. Enucleation with a glass ball implant in Tenon's capsule is the operation of choice. Evisceration should be limited to those cases showing a purulent endophthalmitis.

(2) pending enucleation, or while awaiting the repair of an eye injury, the injured eye is atropinized, ophthalmic ointment applied, and both eyes bandaged. The immobilization of both eyes is particularly important, as movement of the eyes is minimized with lessening of the danger of wound gaping and further prolapse of the intra-ocular tissue.

(3) Every case of perforating injury is x-rayed as soon as possible to determine the presence or absence of an intra-ocular foreign body. The removal of an intra-ocular foreign body should be attempted as soon as possible unless an established iridocyclitis is present. Accurate methods of x-ray localization and a magnet are essential.

c. Maxillofacial wounds.

(1) The hazards to life of initial operative management are oftentimes greater than those of the original wounding. There should be no hesitancy in performing tracheotomy when indications exist to relieve obstruction of the airway by that method. On the other hand, the care of a tracheotomy is difficult in a long evacuation line, sometimes requiring a personal attendant. The choice of the anesthetic agent as well as the techniques of its administration require expert judgment and skill.

(2) The procedures of initial surgery are based on the following principles in order of importance:

(a) Reduction and fixation of fractures of the bony foundation structures. This may be by temporary measures for transportation purposes with the intent that it will be replaced by more elaborate and precise splinting at a rear installation.

(b) Isolation of the buccal cavity from the wounds of the bone and superficial soft parts by suture of the mucous membrane.

(c) Primary closure of the muscles and skin with provision for adequate drainage in anticipation of infection.

(d) Application of moist pressure dressings.

(3) The management of the soft part wound by primary suture, with or without plastic repair, must not tempt the forward surgeon to hold a patient for supervision of healing with the result that precise and firm splinting of the bony parts is postponed.

(4) Those cases with severely comminuted fractures or loss of bony substance and with major soft tissue defects require evacuation to the Zone of the Interior as soon as they can care for themselves and after the dangers of infection have passed.

d. Thoracic wounds.

(1) It is important to recognize two distinct phases that may be encountered in chest wounds - disturbance in cardio-respiratory physiology and infection. The former develops immediately; the latter is usually delayed. Accordingly, in the forward area efforts are directed toward the restoration of

physiologic equilibrium, whereas the less urgent complication of infection, if it occurs, may be controlled adequately at the base. Thus, success in the management of penetrating wounds of the chest depends upon the judicious timing and selection of surgical measures.

(2) Occlusion of open chest wounds with gauze and adhesive strapping is the preferred management until the patient reaches a hospital staffed and equipped to carry out intrathoracic surgery.

(3) Patients with a chest wound suffering from shock may be more advantageously treated in the prone position, with the foot of the litter elevated, than in a sitting position. Control of urgent physiologic disturbances that attend wounds of the chest in both preoperative and postoperative periods can be achieved by:

(a) Needle aspiration of air and blood. Early and repeated aspiration of hemothorax without air replacement is essential in the proper management of chest wounds.

(b) Bronchoscopic or catheter aspiration of blood and mucus from the tracheobronchial tree.

(c) Infiltration of the intercostal nerves with procaine hydrochloride solution for relief of chest wall pain. This enables the patient to cough effectively and clear the air passages of blood and secretions.

(d) Insertion of a catheter with a flutter or water-seal valve for pressure pneumothorax.

(e) Administration of oxygen and whole blood transfusion. Autotransfusion of pleural blood should be used when practical. Care is taken to give the blood slowly in resuscitation after the systolic blood pressure has reached 80 mm of mercury, and the total amount administered should only be that essential to attain adequate resuscitation.

(f) Debridement of sucking wounds with hemostasis of intercostal vessels and approximation of deep structures of the chest wall to close the pleural opening.

(4) An anesthetist well trained in endotracheal anesthesia for thoracic surgery is an essential member of an operating team caring for war wounds of the chest. Endotracheal oxygen ether, administered through a closed apparatus capable of maintaining positive pressure, is the form of anesthesia recommended in the management of penetrating and perforating chest wounds.

(5) Early thoracotomy through an extension of the wound or by a separate incision at a site of election, is indicated in the presence of:

(a) Continuing intrapleural hemorrhage not controlled by hemostasis in the chest wall debridement.

(b) Anatomic likelihood of diaphragmatic penetration.

(c) A missile in the mediastinum or that has traversed the

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mediastinum with evidence of visceral damage.

(d) Large intrapleural foreign bodies or debris that is readily accessible by extension of the wound.

(e) Wounds of large bronchi or the intrathoracic portion of the trachea.

(6) The following conditions are not in themselves indications for early thoracotomy either by extension of the wound or by separate incision:

(a) Foreign bodies, i.e., metallic fragments, or rib fragments in the lung, or small fragments that may be in the pleural space.

(b) Hemothorax (evacuation of blood from the pleural cavity by suction at the time of chest wall debridement is not considered a thoracotomy).

(c) Lacerated or contused lung unless there is definite evidence of continuing hemorrhage.

(7) The incision for thoracotomy or an extension of the wound should be placed in the postero-lateral area of the thoracic cage, rather than anteriorly. Difficulty has been encountered with the breakdown of anterior chest wall defects. Complete expansion of the lung by inflation to the chest wall and evacuation of pleural fluid and air is attained at the end of all operations in which the pleura is opened. Following thoracotomy closed drainage of the pleural space is instituted except under unusual circumstances. The drainage catheter is removed as soon as the clinical course permits, usually at the end of 48 hours.

(8) Rather than invite pulmonary edema by excessive intravenous fluid therapy, it is advisable to keep a patient with an injured lung slightly dehydrated.

(9) Late complications include residual "clotted" hemothorax and empyema.

(a) The accumulation of massive clots of fibrin in the pleural cavity is suspected when clinical findings persist and only small amounts of blood can be withdrawn with the needle. In addition, serial roentgenograms show no improvement during the third to sixth weeks. In such cases thoracotomy is done for the removal of clots from the pleural cavity and the dense layer of fibrin from the underlying lung. Early decortication in these cases permits normal expansion of the lung and prevents chronic empyema and other complications that lead to chronic disability. Penicillin is used both systemically and locally in the pleural cavity at the time of operation.

(b) Post-traumatic empyema demands prompt surgical drainage or, when the patient's condition permits, radical thoracotomy with the evacuation of residual clots and decortication of the lung. The latter procedure should be performed preferably before the sixth week, because the surgical line of cleavage becomes obliterated after this time by organization of inflammatory exudate. Systemic and local penicillin is used as an adjuvant.

e. Abdominal Wounds.

(1) Resuscitation. Surgical management of penetrating wounds of the abdomen demands rapid resuscitation with adequate amounts of whole blood and plasma and early operation. Continuing internal hemorrhage or advancing peritonitis frequently prevents a satisfactory response to blood transfusion, forcing the surgeon to proceed with operation and rely on support of the patient by transfusion during and after surgery.

(2) Preoperative Measures. Naso-gastric intubation with removal of gastric contents is an important measure to prevent the aspiration of this material during anesthesia. It is a fortuitous event when passage of the tube provokes vomiting. Rectal examination to determine the presence of fresh blood indicative of injury to the rectum and testing of the nerve function of the extremities are the two most commonly overlooked features of the preoperative examination.

(3) Anesthesia. Ether-oxygen anesthesia with a closed system, and preferably with an intratracheal tube is the method of choice. Supplemental block of the field either by local infiltration or injection of the lower intercostal spaces in the axillary line may minimize the necessity for carrying these patients into the deeper levels of general anesthesia. Facilities should be available for bronchoscopy during or subsequent to the operation if there is reason to believe that gastric contents have been aspirated into the tracheo-bronchial tree. Postoperative aspiration pneumonia ranks with peritonitis as a life-endangering complication.

(4) Operative Considerations.

Incision. The vertical paramedian incision affords the most useful approach and is least liable to complications. Fecal contamination of the peritoneal cavity will be reflected by postoperative infection of the abdominal wall incision in a considerable number of instances. The principles that apply to the management of heavily contaminated soft part wounds also apply to abdominal wall incisions provided steps are taken to prevent evisceration. The peritoneum is closed, usually including the posterior rectus sheath in the suture line. The rest of the abdominal wall is loosely approximated, preferably with stay sutures. The skin is left unsutured. The provision of adequate drainage for the abdominal wall incision, the avoidance of buried sutures and ligatures, and a loose rather than taut approximation of the stay sutures are the most effective measures in the prevention of infection.

When it is necessary to exteriorize segments of bowel or to provide intraperitoneal drainage for or in anticipation of localized sepsis or a fecal fistula, secondary incisions are made. These are short, laterally placed incisions that follow the direction of the fibers of the external oblique muscle. In the upper abdomen incision for exteriorization of bowel must not impinge on the costal arch.

Small Bowel Injuries. Depending upon the extent of damage, repair is done by suture or by resection and anastomosis. Exteriorization of small intestine or double-barrelled enterostomy is avoided as productive of serious life-endangering complications.

Large Bowel Injuries. A distinction is made between: (1) exteriorization of a wounded segment of bowel and (2) construction of a colostomy to divert the fecal stream. At times both purposes may be accomplished by one and the same procedure, but a clear understanding of the purpose of the operation is essential to the selection of techniques involved. For either purpose the basic technical requirement is adequate mobilization of the segment of the large bowel that is brought to the surface of the abdominal wall. Insufficient mobilization with dependence upon suture or clamps to maintain the bowel in its abnormal position will result in retraction. Retraction leads to a fecal fistula that may be difficult to repair, or in the case of a defunctioning colostomy, defeats the purpose of the operation by allowing fecal matter to enter the distal segment. Early in the convalescence, retraction is productive of abdominal wall infection or intraperitoneal sepsis.

Exteriorization. Exteriorization of the damaged segment through a laterally placed muscle splitting incision is the established procedure in the management of wounds of the large intestine. The defect in the bowel may be closed by suture if so desired, provided it is left exteriorized. The loop of bowel must lie comfortably on the abdominal wall without tension and with proper orientation of its proximal and distal limbs, i.e., not twisted upon itself. The mesentery falls naturally into a fold on the medial aspect of the loop, leaving the bowel walls in contact on the lateral side. Properly performed, this simple procedure is adequate in the majority of instances when exteriorization is all that is required. Closure is made by suture or the application of a spur clamp in the area where the two limbs of the bowel are in contact.

When the injury is larger than one half the diameter of the bowel or a segment has been resected because of damage to the mesentery, exteriorization takes the form of a double-barrelled spur. Sutures may be placed to approximate the ante-mesenteric borders of the intraperitoneal portions of the limbs for subsequent crushing by a clamp. Care must be taken not to penetrate the lumen of the gut or strangulate vessels by sutures.

Colostomy. Colostomy to divert the fecal stream is required for (1) injuries of the pelvic colon where the bowel where exteriorization is possible. In such a instance the perforation is repaired by suture and proximal colostomy done; (2) wounds of the rectum; (3) certain perineal and buttock wounds as an adjuvant to wound healing and secondary suture.

An appraisal of the length of time that it may be necessary to defunction the distal bowel segment guides the technical details of construction of the colostomy, as well as determine the site chosen for the artificial anus. A tube cecostomy or partial exteriorization of the cecum does not divert the fecal stream from the remainder of the colon, and is never used for this purpose. Colostomy in the left half of the transverse colon is a useful procedure in the case of extensive pelvic injuries that may require subsequent repair by the abdominal route. This is particularly the case if a suprapubic cystostomy is also indicated, or if the missile has produced a large tear to the abdominal wall in the left lower quadrant. Usually, however, a left sigmoid-colostomy will be satisfactory for injury of the pelvic colon or rectum and for perineal injuries. Placement of the colostomy in a defect produced by the missile or in the laparotomy incision is to be avoided. Formation of a loop with proper lateral orientation of the bowel, assured if desired by the placement of a few absorbable sutures on the ante-mesenteric borders or by suture of multiple tags, provides an adequate

in mid-colotomy. Manual construction of a long spur is not necessary and may be undesirable.

Extensive damage to the lower bowel segment, associated injury of the bladder and urethra, and wounds that extensively compound the bony pelvis, as well as the rectum, are examples of injuries that require a prolonged and careful reconstruction of artificial anus. Under these circumstances the external loop is made sufficiently long to allow for complete transverse section of the bowel and some separation of the two stomata. As ultimate closure will be by end to end suture, formation of a spur is undesirable. Construction of a skin bridge between the arms of the loop would, in fact, be preferable.

Small perforations of the rectum, or instances in which the perforation cannot be demonstrated but is thought likely, may not require prolonged or even complete diversion of feces. Small wounds of the recto-sigmoid may heal properly if suture is technically satisfactory. Under such circumstances, formation of a loop colostomy with a tentative partial opening in the ante-mesenteric border will suffice at least until a complete appraisal can be made at a fixed hospital. Many of these cases can be restored to duty within an overseas theater by extra-peritoneal repair of the incompletely divided loop. If the need for long and complete diversion of feces is demonstrated, the loop is completely transected to form an artificial anus.

Celostomy as an aid to the healing of wounds of the buttocks and perineum may not be performed in the forward areas, unless laparotomy is being performed for other purposes. If used solely for management of the external wound, the patient will be rendered non-transportable because of a procedure that could have been postponed until arrival at a fixed hospital.

Cecostomy. Terminal perforations of the cecum may be managed by a tube cecostomy or, preferably, by externalization. Simple perforations require mobilization of the bowel to look for retroperitoneal perforation. Cecostomy, even when necessary because of direct injury to the cecum, is never to be used as a substitute for a proximal colostomy when indications for the latter are present.

Right Colostomy. In extensive injuries necessitating resection of the cecum and ascending colon, the most important principle to observe is complete separation of the ileostomy from the laparotomy incision or from a large abdominal wall defect. The two most satisfactory methods for dealing with the end ileostomy are: (1) Separation of the ileum and the proximal end of the colon by creating a terminal ileostomy in a gridiron incision in the right lower quadrant and exteriorization of the end of the colon below the costal margin. Subsequently, reconstruction may be done by anastomosis of the ileum to the transverse colon and excision of the blind pouch of colon; (2) the ileum and proximal end of the divided colon are exteriorized as a long sutured double-barrelled ileocolostomy, the spur of which may be later crushed with a clamp.

Perforations of the pelvis. Wounds of the rectum are characterized by inaccessibility, difficulty in diagnosis, traumatic damage to other structures and the hazard of pelvic and secondary retroperitoneal abscesses. Deviations from the principles established for the management of wounds of the rectum continually lead to serious complications. Celostomy (not cecostomy) is mandatory, as this is free posterior drainage, most satisfactorily insuring the fascia propria

exposing the rectal, sacral, and lateral pararectal spaces. Attempts to drain the retroperitoneal space by utilizing the missile wound of the buttock have been disastrous. In establishing posterior drainage it may be desirable to increase the exposure by removal of the coccyx. This is done as a disarticulation of the coccyx from the sacrum by sharp dissection and crushing of exposed articulating cartilage - not by incomplete amputation with a bone forceps.

(2) Postoperative Care. The postoperative care of patients with abdominal wounds is of the utmost importance and is the personal responsibility of the operating surgeon. Among the most important considerations are:

(a) Holding of the patient until his equilibrium is established - oftentimes a minimum of ten days.

(b) Nasogastric suction for 48 hours or more following operations.

(c) Whole blood and plasma.

(d) Parenteral fluid therapy is controlled by measurement of fluid intake and output and by determinations of cell volume and plasma protein concentration by the copper sulphate method. A daily urinary volume of 1200 to 1500 cc is maintained, a point of particular importance in connection with the use of sulfadiazine.

(e) Aspiration of tracheobronchial secretions. Postoperative pulmonary complications including pneumonia, atelectasis, and pulmonary edema are common in this group of patients. Oxygen therapy by means of an indwelling nasal catheter and aspiration of tracheobronchial secretions by catheter or bronchoscope are important measures and may be required frequently.

In cases that develop sepsis, small intestinal fistula, intestinal obstruction and other complications or sequelae it is essential to:

(a) Maintain nutrition by supplemental feedings.

(b) Correct the tendency toward vitamin depletion.

(c) Promptly diagnose and drain localized sepsis.

(d) Close small intestinal fistulae at the earliest moment that operative intervention can be tolerated.

(e) Closure of Colostomy. A malfunctioning colostomy deteriorates into a useless one. It will ulcerate and at the longer intervals the ulcer from the distal bowel. Regardless of the purpose of its continuation must be closed or it should either be closed or re-established as an effective artificial anus. Spillage of feces into the lower segment results in fecal impaction and delays healing of the wound of the bowel wall.

In overseas theaters it is desirable to close certain colostomies and repair exteriorizing anastomoses when this can be done by suture of a partial defect of the bowel or by crushing a spur. Patients requiring a formal end-to-end anastomosis are best transferred to the United States as the likelihood of return to duty is slight.

1. Peripheral vascular injuries.

Peripheral vascular injuries are of special importance, particularly where major vessels are involved. In many of these cases ligation or end suture will be necessary. Ligation in continuity should not be done. In the presence of a thrombus, the thrombosed segment is excised. Localized segmental spasm of the artery should be distinguished from thrombosis. Such cases, also termed "concussion" or "stupeur" of the artery, may follow various forms of trauma to an extremity, especially when the traumatizing agent passes near a vessel. In such cases the limb is pale, pulse and pulsations, but evidence of hemorrhage or hematoma is lacking and the vessel has been lacerated is lacking. These cases respond well to debilitation of surrounding traumatized tissue and to periarterial sympathectomy or sympathetic block. Postoperatively in all cases with peripheral vascular injuries vasodilatation may be induced by daily sympathetic block using one per cent procaine hydrochloride solution. Body warmth is carefully maintained but heat should not be applied to the involved extremity.

The position of the extremity is important, as elevation may accentuate ischemia. A dependent position is preferable even if a moderate degree of edema appears to be the result. A plaster cast on an extremity threatened by ischemic gangrene is divided into the anterior half removed. Continuous observation is essential to detect impending anaerobic infection. Repeated transfusions to establish a normal blood volume and maintain a high red cell volume is an important phase of management.

A patient with impending ischemic gangrene should be held at the initial surgical immobilization until a favorable result is assured or amputation is performed.

Operation for the extirpation of an aneurysm or an arteriovenous fistula is rarely an emergency procedure. Since wounds causing aneurysms may be infected, and since extravasation of blood into the tissues surrounding the wound usually occurs, delay in operation will diminish the chance of secondary infection and secondary hemorrhage. Moreover, operation should be performed as early as possible as distal circulation has been established, so that major vessels may be safely ligated and divided. This will usually require three or four months. Early operations are undertaken not for the cure of aneurysm but to arrest certain complications, viz. hemorrhage, impending rupture, nerve paralysis caused by pressure or threatened gangrene of the extremity. In such cases, repeated sympathetic block using 1 per cent procaine hydrochloride solution (or sympathectomy, if indicated) should be done both pre and postoperatively to assure maximum vasodilatation and thus increase circulation in the involved part.

g. Peripheral Nerve Injuries.

(1) Complete Palsy with Anatomic Division of Nerve.

Primary suture of peripheral nerve injuries is advisable only during a period when small numbers of casualties are being handled or expected.

In selected cases of soft part wounds uncomplicated by extensive muscle damage or skeletal fracture, complete or partial severance of a nerve may be repaired by formal suture technique. A particular incident is laceration. Closure of the soft parts over the suture line without tension is advisable with primary

or staged closure of the skin. This procedure should be undertaken only if the patient may be held under observation of the operating surgeon for a period of ten days, and is not recommended if the wound is heavily contaminated by debris or evacuation from the field has been delayed. Primary nerve repair must never be undertaken at the expense of delay in debridement or neglect of concomitant injuries.

The more usual method of management will be by undertaking formal nerve suture as a phase of reparative surgery in the following stages:

(a) It is the responsibility of the surgeon at the time of the initial debridement to make a careful record of the injury as he observes it. Preoperative appraisal of nerve injury is notoriously difficult and inexact in patients with multiple wounds, particularly if they are suffering from shock. The most precise information comes from anatomic observations at operation. Here again, it is not desirable to embark upon a painstaking dissection with extension of the field of operation beyond the zone of devitalized tissues.

(b) No attempt is made to repair the nerve by suture or fix the nerve ends. Exposed nerves are covered with muscle so that the dry fine mesh gauze used in the wound is not in contact with the nerve. Vaseline gauze is not used.

(c) Dusting of the wound with sulfonamide after debridement may be omitted - certainly in the area of the nerve trunk.

(d) The joints above and below the point of injury are immobilized to minimize retraction of the nerve.

(e) A firm pressure dressing supported by a plaster of Paris shell is applied to reduce wound exudation.

(f) Penicillin therapy is maintained by the systemic route.

(g) On reaching a general hospital the original dressing is removed under aseptic precautions in the operating room. This usually is possible on or shortly after the fourth week after injury. The depth of the wound are revisited and the nerve injury reassessed. Electrical tests may be made if desired. Often-times a more deliberate examination will correct or supplement the initial notes made in the forward area. Appraisal at this time is based on the ultimate functional restoration of the extremity, taking into consideration muscle damage and bone or joint lesions in relation to the nerve injury. Procedures such as muscle suture or even shortening of the limb by removal of devitalized comminuted bone fragments may be carried out at this time. The divided ends of the nerve may be approximated by a single fibrous suture or, preferably, allowed to rest under the protection of normal muscle bundles. The wound is closed if sepsis is not present, or if further excision of contaminating tissue adequately prepares the wound for closure. Closure of the skin may be further staged, or if a large skin defect exists, a skin graft is applied at once or as a staged procedure.

(h) When first intention healing has been secured - and this results in 80 to 90 per cent of cases - formal repair of the nerve is undertaken. This should be feasible in many cases during the fourth week after secondary wound repair.

(b) patients with major nerve injuries, whether suture has been performed or not, should be transferred to the neurosurgical centers in the United States with the least possible delay.

(c) It is important that casts be removed at the earliest possible time. Cases are being received in the zone of the interior with muscle atrophy and joint stiffness resulting from unduly long periods of immobilization in plaster. Light removable splinting that permits supervised motion and physiotherapy should be substituted.

(2) Partial or Transient Palsies make up perhaps one fourth to one third of the nerve lesions arriving at the base. Recovery from a laceration or concussion often begins within a few days, while more extensive injuries may proceed over a much longer period of time. In these cases it is desirable but not imperative to identify the injury to the nerve trunk at the time of primary debridement or secondary wound suture.

b. Amputations.

(1) The most important phase in the management of amputations is the functional rehabilitation of the patient by the fitting of a prosthesis. Amputation centers have been established in the Zone of the Interior for this purpose. It is the expressed desire of The Surgeon General that the early management of amputations in overseas theaters conform with policies that have been set forth in numerous bulletins and Circular Letters and which are summarized below.

(2) In the forward area, amputations will be performed at the lowest possible level except that a proximal amputation will be done in preference to a disarticulation. The technique for the performance of amputations is as follows: A circular incision is made through the skin at the lowest level compatible with viable tissue, and the skin allowed to retract; the fascia is then incised at the level to which the skin has retracted. The superficial layer of muscle is then cut at the end of the fascia and permitted to retract. At its point of retraction, the deep layers of muscle are cut through to the bone. After the deep muscles have retracted, the periosteum of the bone is cleanly incised and the bone sawed through flush with the muscles. No cuff of periosteum is removed as in a closed amputation. Bone denuded of periosteum will sequestrate if infection is present and a ring sequestrum often results when the periosteum has been removed. It is important also that no periosteum be elevated or torn from the bone in the stage of rough handling. The properly performed flapless guillotine stump exhibits a slightly concave open cross section of the extremity.

(3) The proper dressing of the stump is important. The end of the stump is dressed with fine mesh gauze in such a manner that it does not overlap the skin edges. Skin traction is applied immediately. This may either be by a stockinette cuff attached with ace bandage or by adhesive tape. Traction is obtained preferably by a light plaster cast with a wire leather strap. The cast should incorporate the joint above the amputation, e.g., a splice for an amputated thigh. The Army Hinged Half-Ring splint may be utilized as an alternative. Medical supply item no. 30414, Cord, Traction, for traction, is well liked and is preferable to "chain" tubing for the double traction. Before even then, the traction is applied and if doubt exists as to its effectiveness, it is reapplied.

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(4) At the base areas, secondary closure of a circular guillotine amputation stump is not indicated, as it is impossible to suture the inelastic fascia without wasteful shortening of the bone. Bone length can be saved by continuing the skin traction for an additional period of time - 4 to 6 weeks. Closure of stumps by sliding flaps, plastic resection with sacrifice of bone length, or formal reamputation are procedures to be carried out in the zone of the Interior rather than in an overseas theater. Skin grafting is not indicated. Vertical incisions in the stump made for control of infection or as part of the initial debridement should be closed by secondary suture while skin traction is being maintained to cover the defect at the end.

(5) In the communications zone continuous skin traction is maintained in all cases. After removal of the cast or splint, maintenance of 4 to 6 pounds in below-knee and 6 to 8 pounds in thigh stumps of traction over a pulley at the foot of the bed is indicated. Traction is continued until the wound is healed. Priority air evacuation to the Zone of Interior should be available for amputation cases as soon as they are able to be transported. Traction during evacuation is provided for by stockinette and a banjo plaster.

i. fractures.

(1) The management of a compound fracture is divided into the following phases: first aid splinting in the field; debridement and the application of transportation splinting in a mobile hospital; final correction of the deformity and attainment of wound healing and bony union at a fixed hospital (reparative phase); reconstructive or corrective surgery (bone grafting, osteotomy, sequestrectomy, etc.) in the zone of the Interior. In every phase attention is directed to the ultimate function of the extremity which is dependent on muscles, nerves, blood vessels and joints as well as on skeletal integrity.

(2) Transportation Splinting applied subsequent to initial wound surgery for evacuation from mobile to fixed hospitals is not designed to provide anatomic reduction or prolonged fixation in suitable reduction. Except in rare instances it is by plaster of paris. plaster bandages are adequately padded and bivalved or split through all layers to the skin. Skeletal fixation by the incorporation of pins or wires into the plaster is not recommended. The only indication for the use of internal fixation in the forward area is to preserve the vascular integrity of the extremity.

Methods of transportation splinting that have proved safe and comfortable are:

Femur: A low waisted "one and one half" plaster spica with the knee slightly flexed and minimal abduction.

The Tobruk plaster and the Army log splint with skin traction do not provide as adequate immobilization and should only be used as emergency measures when large numbers of casualties or multiple wounds in a single casualty demand concessions to operating time or for special indications such as the presence of a colostomy or suprapubic cystostomy. When restricted to lower third femoral fractures and knee joint injuries the Tobruk splint provides adequate immobilization.

humerus: A thoracobrachial plaster with the arm forward in internal rotation.

A plaster Velpeau bandage binding the arm to the trunk with the forearm flexed at a right angle and placed across the chest.

The Army humerus splint designed for field (first aid) use is not suitable for postoperative transportation splinting.

A hanging cast is both uncomfortable and ineffective as a method of transportation splinting.

Forearm:

A circular plaster bandage that extends to the mid-brachial region with flexion of the elbow and extending only to the proximal palmar crease.

Plaster slabs in the form of "sugar-tongs".

Tibia and Fibula:

A circular plaster bandage from toes to groin. The knee is slightly (15 degrees) flexed and the foot held in neutral position at 90 degrees to the axis of the limb. A plantar slab may extend beyond the toes to afford protection, but hyperextension is to be avoided.

(3) Reparative Surgery of Compound Fractures. (See Wound Management, par. 2 c on Closed Plaster Treatment).

Reparative surgery in compound fractures is made necessary by leaving unsutured the large incisions made for debridement and the recognized fact that splinting suitable for transportation is inadequate for complete reduction and fixation of the fracture. The goal is functional restoration of the extremity and demands treatment of muscle and nerve injury as well as skeletal damage. Observance of certain basic principles are important to the success of this phase of management.

Preoperative correction of anemia by whole blood transfusion.

Despite whole blood transfusion for resuscitation in the forward area, a high percentage of compound fracture cases will arrive at a fixed hospital in the Communications Zone with low red cell volume (hematocrit) and hemoglobin. An approximate estimate of the quantity of whole blood needed to restore red cell volume may be deduced from the rough rule of 500 cc blood for each 3 points of the hematocrit or 0.9 grams of hemoglobin. In the use of whole blood transfusion for correction of secondary anemia or hypoproteinemia the total volume administered in a 24 hour period should not exceed 1000 cc except to replace blood lost at operative procedures. This is in contrast with the larger volumes that are administered for resuscitation when the total circulating blood volume may be greatly reduced. No correlation exists between the hematocrit or hemoglobin levels and circulating blood volume and care must be taken not to precipitate pulmonary edema by overtransfusion of a patient in whom the blood volume has been restored by dilution but who still shows a greatly reduced cell volume (hematocrit) and hemoglobin.

The surgical elimination of residual necrotic tissue. No available chemotherapeutic agent can "sterilize" an open wound containing devitalized

tissue or blood clot. A properly managed clean wound requires no local anti-septic.

The control of invasive infection by systemic chemotherapy. Systemic penicillin therapy in a dosage of 25,000 units every three hours is recommended as a routine adjuvant for secondary operations on compound fractures. Treatment is continued postoperatively until the likelihood of invasive infection is passed.

Reduction or closure of soft tissue defects. Exposed cortex of bone, nerves and tendons are vulnerable to the necrotizing effect of wound suppuration and are protected by the apposition of adjacent soft parts. Transversely divided important muscle groups are united by suture. Fascial compartments are restored to minimize scarring and improve muscle function. Certain of these procedures may be staged operations. Emphasis should not be placed on early or complete skin closure, as in most cases any remaining cutaneous defect will heal before bony union occurs.

Provision of drainage for residual exudate. Severely comminuted fractures may require dependent drainage in association with the apposition of soft parts over exposed bone. Exteriorizing fascial plane incisions have proven superior to stab wounds or rubber drains. Upper extremity fractures rarely present a drainage problem. The thigh may be drained by a posterolateral incision between the vastus lateralis and the biceps. An adequate posterior drainage route for the shaft of the tibia does not exist and such an injury may necessitate a period of "on the face" nursing.

Internal fixation of battle fractures is not feasible commonly because of extensive comminution. Further, the method demands further periosteal stripping and surgical trauma to the wound. Limitation of the use of this method to cases carefully selected by specialists fully experienced in the techniques and hazards of its usage is strongly advised. An example of sound usage is the employment of screws for restoration of the articular surface of a major joint. Reduction of the fracture is the goal of reparative surgery - not the use of internal fixation.

Use of suspension traction. The application of suspension traction in the treatment of fractures, particularly those of the femur, is the safest and most satisfactory method of management. In fixed hospitals fractures of the femur should be treated by skeletal traction for ten to twelve weeks until enough union has been obtained to permit safe transportation to the Zone of the Interior in a plaster spica. The use of suspension traction promotes the maintenance of joint and muscle function and prevents angulation or over-riding deformity.

Overpull and resulting distraction must be avoided at all times, particularly in cases associated with injury or division of the thigh muscles. Certain cases of this type require very expert attention and delay in the application of traction until firm fibrous union of muscles has been attained by suture.

J. Joints.

Early complete debridement is the keystone of success in the management of wounds that compound a joint. The wound of the soft part is excised and the bone and cartilage damage assessed through incisions that provide complete exposure. Comminuted fragments of bone and cartilage are removed from the joint

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and a careful search made for foreign material. Badly comminuted fractures of the patella are excised completely as a step in the debridement of a knee joint wound.

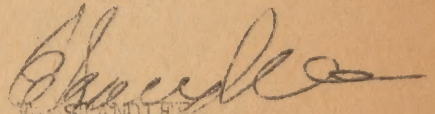
Every effort is made, after cleansing the joint cavity, to close the capsule. The skin is left unsutured. Closure of the joint is especially difficult in the face of extensive loss of soft parts. When it is impossible to close a joint by suture of synovia or capsule, an occlusive dressing is applied. On arrival at a fixed hospital, effort is directed toward closing the defect by advancement of a skin flap or other plastic procedure.

Adequate exposure of the hip joint is a specialized procedure that requires precise anatomical orientation. The same principle of management must be applied to improve the results of this particular lesion.

Penicillin is inserted into a joint at the end of the operation. In joints that are accessible to needle aspiration, accumulating exudate may be withdrawn and penicillin injected during the postoperative period.

Wounds of the ankle joint with comminution of the os calcis or astragalus are peculiarly liable to sepsis. Initial debridement of comminuted bone fragments must be minimal if function is to be preserved and early efforts are made in the reparative surgical phase to reduce or close the skin defect with split thickness graft when necessary. When sepsis is established, subperiosteal excision of necrotic bone fragments followed by wound closure by graft or suture should not be delayed.

For the SURGEON:


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